Center Independent Research & Development: GSFC IRAD

Three-Axis Gasless Sounding Rocket Payload Attitude Control

Completed Technology Project (2016 - 2017)

Project Introduction

Gas released by current sounding rocket payload attitude control systems (ACS) has the potential to interfere with some types of science instruments. A single-axis gasless ACS experiment was successfully flown on a sounding rocket. The single-axis system is being expanded to three axes to provide gasless attitude control with greater accuracy than is presently achievable.

Sounding rocket payload attitude is currently controlled by a system of cold gas thrusters. The gas released by the thruster has the potential to interfere with science instruments that are sensing matter in the local environment. There is interest in the sounding rocket science community in an ACS that can provide fine attitude control without releasing gas. A three-axis reaction wheel assembly (RWA) can provide gasless fine attitude control during science operations. Large maneuvers and coarse control would still be provided by the standard cold gas thrusters, but the gas would be shut off and control would be handed over to the RWA during portions of the flight critical to sensitive science instruments. In addition to being gasless, a RWA ACS can also provide more precise attitude control than can be achieved through pulsed thrusting of a cold gas system.

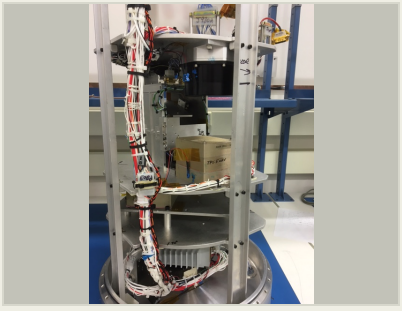
A single-axis gasless ACS proof of concept experiment was flown March 1, 2016.

The scope of the project is to expand the single-axis system used for the proof of concept flight into a three-axis ACS. Existing software for the controller and software-in-the-loop (SWIL) simulation testing will need to be expanded to include pitch and yaw axes. Maneuver limits and wheel saturation rates with typical disturbances will be estimated to create a trade space of hardware requirements, and hardware that meets those requirements will be identified. Potential processors will be evaluated. Wheels will be sized for the pitch and yaw axes and re-evaluated for the roll axis. Capability for spinning attitude control will also be added. Performance estimates will be made for both the LN-200 and the more accurate LN-251 IRU.

The overall objective of the project is to mature the three-axis design to the point that it will represent a minimal schedule risk when included in either a Sounding Rocket Program Office (SRPO) development mission or a science mission willing to take a risk on a developmental system, and to develop an accurate cost estimate to aid in securing funding for a flight demonstration. Project deliverables will include controller software for both spinning and non-spinning payloads, a set of hardware requirements for the system, and performance and cost estimates for the system.

Anticipated Benefits

Producing a reaction wheel attitude control system for sounding rockets will provide greater capabilities to the services offered by the Sounding Rocket



Single-axis experiment mounted in MUSIC payload.

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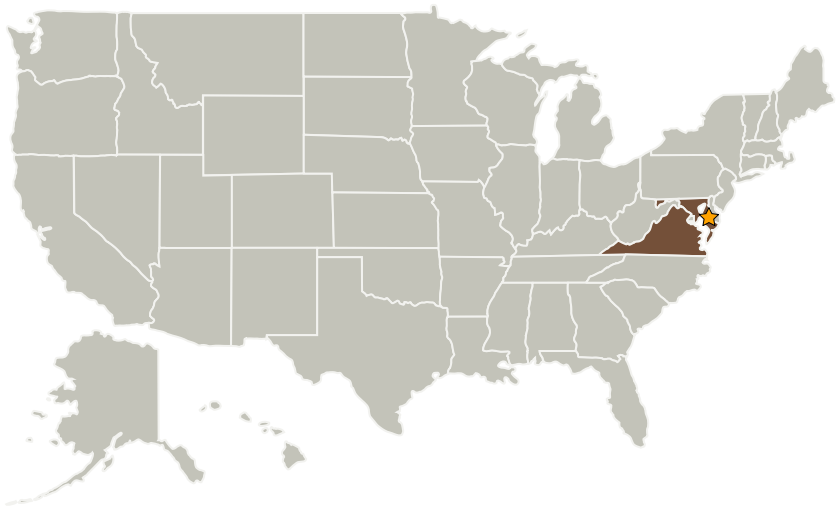
Program Office. Any NASA mission requiring tight pointing performance will benefit from the system, and any mission requiring a gasless environment.

The added capabilities provided by the system will benefit any organization that uses a sounding rocket platform. Commercial entities can benefit either through technology development or through partnerships or providing space flight products to government or university science teams.

The added capabilities provided by the reaction wheel ACS will benefit any organization that uses a sounding rocket platform, including military and other government organizations.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Wallops Flight Facility(WFF)	Lead Organization	NASA Facility	Wallops Island, Virginia

Primary U.S. Work Locations	
Maryland	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Wallops Flight Facility (WFF)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

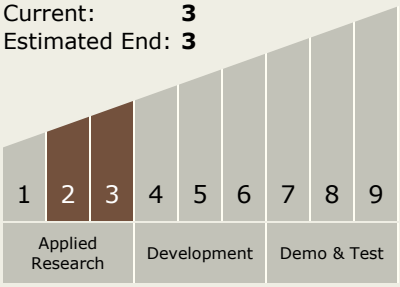
Jason W Mitchell
Daniel A Mullinix
Michael A Johnson

Principal Investigator:

Zachary W Peterson

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Project Transitions

October 2016: Project Start

September 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center's Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard's IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.3 Control Technologies
    - TX17.3.1 Onboard Maneuvering / Pointing / Stabilization / Flight Control Algorithms

Target Destination

Earth

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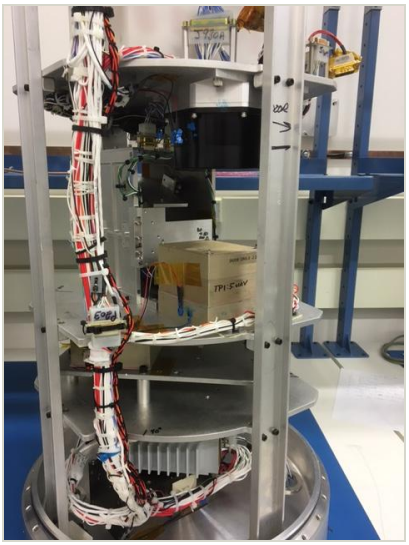
Images



Single-Axis Experiment Mounted in MUSIC Payload
Single-axis experiment mounted in MUSIC payload.
(https://techport.nasa.gov/image/24477)

Project Website:

http://aetd.gsfc.nasa.gov/